THE RELATIONSHIP BETWEEN ANXIETY-STABILITY, WORKING MEMORY AND COGNITIVE STYLE

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SUMMARY

While prior research indicates that relationships exist between anxiety-stability and working memory, and cognitive style and anxiety-stability, they have not been considered together. The aim of this study was to consider how anxiety-stability is related to working memory, gender and style in interaction. The sample consisted of 179 12-13-year-old Year 8 secondary comprehensive school pupils in the UK. Teachers rated the level of anxiety-stability of pupils. Pupils completed an assessment of working memory efficiency, the *Information Processing Index* (IPI) (Riding, 2000a). They also did the *Cognitive Styles Analysis* (Riding, 1991) to determine their positions on the two fundamental cognitive style dimensions, which were indicated by two ratios - the Wholist-Analytic ratio and the Verbal-Imagery ratio. Working memory capacity and cognitive style interacted in their relationship with anxiety-stability, such that higher memory was associated with a greater increased stability for Wholist-Verbalisers and Analytic-Imagers than for Analytic-Verbalisers and Wholist-Imagers. The results were discussed in terms of the unitary versus complementary nature of style combinations.

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INTRODUCTION

The intention was to examine the relationship between anxiety-stability, working memory capacity and cognitive style. Anxiety-stability is recognised as a basic dimension of personality. Working memory refers to the temporary storage of information that is necessary for performing cognitive tasks such as comprehension, reasoning, and learning. Cognitive style is an individual's preferred and habitual approach to organising and representing information. These variables are likely in an interactive manner to affect stability. A tentative interactive model is shown in Figure 1. The basic components of this model will be briefly discussed.

(Figure 1 about here)

Anxiety-Stability

In general, anxiety is a feeling of fear, dread, nervousness and worry. The feeling has associated physiological symptoms including increased blood pressure, rapid heartbeat, sweating, dryness of mouth and weakness, (see, for instance, Spielberger and Rickman, 1991, p69). Trait anxiety is seen as relatively stable individual differences in anxiety proneness (Spielberger, Ritterband, Sydeman, Reheiser and Unger, 1995, p44), while state anxiety fluctuates over time with the external conditions, (M.W Eysenck, 1992, p38). Some workers distinguish between anxiety and neuroticism, (see Gray and McNaughton, 2000, p337). Trait anxiety is generally seen as largely genetically determined. In the present research, stability is seen as the opposite to anxiety, and they are seen to be on a continuum. Both trait and state anxiety are important when considering academic work as the two are additive. In addition, it has been suggested that some academic subjects elicit specific anxiety, the more common of these being maths anxiety and computer anxiety (Miller and Bichsel, 2004; King, Bond and Blandford, 2002). In the present model state anxiety-stability is intended.

Anxiety-Stability and Working Memory. A relationship between anxiety level and memory capacity has been observed by several researchers, (e.g., Eysenck, 1992; Calvo and Eysenck,

1996; Elliman, Green, Rogers and Finch, 1997; Hopko, Ashcraft and Gute, 1998). The general view is that some of the capacity of working memory is devoted to the objects of anxiety, and this reduces the resources available for general processing. Studies indicate that individuals with higher working memory will benefit in high anxiety situations (Miller and Bichsel, 2004).

Working Memory

Working memory refers to the temporary storage of information that is necessary for performing cognitive tasks such as comprehension, reasoning, and learning. Research on working memory has been reviewed by Baddeley (1999, 2000).

The working memory system comprises three components: the central executive, and two slave systems - the phonological loop and the visuo-spatial sketch pad, (Baddeley, 1986; Baddeley and Hitch, 1974). Information is processed by either the phonological loop or the visuo-spatial sketch pad, or by both. The central executive is responsible for the control and integration of information from the phonological loop and visuo-spatial sketchpad. These elements individually and collectively have limited processing facility.

Basically, new information is temporarily stored in working memory while its meaning is determined prior to the transfer to the more permanent long-term memory. A practical feature of working memory is its limited capacity and the vulnerability to loss of information in it from displacement by further incoming information.

Individual Differences in Working Memory Capacity and Performance. Since working memory has a limited capacity and is crucial in information processing, individual differences in memory capacity are likely to be reflected in performance.

There is evidence that working memory capacity differs among individuals, and that this difference affects a wide range of cognitive tasks such as problem solving, reasoning, acquiring new vocabulary words, and reading comprehension, (e. g. Cantor and Engle, 1993; Conway and Engle, 1994; Daneman and Carpenter, 1980, 1983; Engle, Cantor and Carullo, 1992). However, as Baddeley (2000, pp 86-87) has noted, there is the possibility that apparent working memory capacity may actually reflect differences in the efficiency of

processing strategies or skills rather than differences in working memory capacity, as such. In practice it appears likely that there are both differences in capacity and in skill efficiency.

Working Memory Assessment. Efforts have been made by several researchers to measure working memory capacity, (e. g. Daneman and Carpenter, 1980; Daneman and Tardif, 1987; Turner and Engle, 1989; Shah and Miyake, 1996). Variations on the Daneman and Carpenter (1980) method have been widely used.

Working Memory Span. Daneman and Carpenter (1980) devised the Working Memory Span test (WMS) to measure working memory capacity. In this task, subjects are asked to read aloud or listen to a series of unrelated sentences of moderate complexity and then to do two things: (a) to comprehend each sentence; (b) to remember the last word of each sentence. The task typically starts with two sentences and increases to a point at which subjects are no longer able to recall all the terminal words. Memory span is then measured by the number of sentences in the largest set of sentences for which a subject is able to remember the last word of each sentence.

An alternative approach is the *Information Processing Index* (Riding, 2000a). This computer-presented assessment shows railway trains comprising carriages of different colours entering the left side of a station into which the whole train disappears from view and then reappears on the right side with some carriage colours changed. The task is to indicate by pressing one of two marked keys, whether or not each carriage colour has changed. This is done as each carriage emerges from the station. While this is being done, the information about the remaining carriages that are still obscured has to be retained in working memory. Except in the case when there is only one carriage, both retention and information processing are required. Since both the amount to be retained and the quantity of processing increases with the length of the train, the total number of carriages correctly identified is taken as the indication of working memory efficiency.

Cognitive Style

Cognitive style is seen as an individual's preferred and habitual approach to organising and representing information (Riding and Rayner, 1998, p11). The background to cognitive style has been reviewed by Riding and Cheema (1991). They concluded that the various style

labels could be accommodated within two fundamental style dimensions - the Wholist-Analytic and the Verbal-Imagery - which may be summarised as follows.

(1) The *Wholist-Analytic* dimension of whether an individual tends to *organise* information in wholes or parts.

(2) The *Verbal-Imagery* dimension of whether an individual is inclined to *represent* information during thinking verbally or in mental pictures.

The two basic dimensions may be assessed using the computer-presented *Cognitive Styles Analysis*[1] (Riding, 1991).

While some have found a low test-retest reliability particularly on the Verbal-Imagery sub-test, (e.g., (Peterson, Deary and Austin, 2003), since there is extensive evidence of its construct validity at least on the first presentation (see for instance the review by Riding and Rayner, 1998), in the absence of a better instrument the CSA is employed in the present study.

Cognitive Style and Anxiety-Stability. Riding and Wigley (1997) with College of Further Education students found an interactive effect of Wholist-Analytic style and Verbal-Imagery style on neuroticism, as assessed by the EPQ-R. Neuroticism was highest for the Wholist-Verbalisers and the Analytic Imagers and lowest for the Analytic-Verbalisers and the Wholist-Imagers. As discussed below the first two style combinations may be seen as being 'complementary' in that they supplement one another, and the latter two 'unitary' and duplicating one another.

The cognitive styles may be considered to be *complementary* when the two style dimensions supplement one another. For example, with Wholist-Verbalisers, verbalisation provides an analytic element, and with Analytic-Imagers, an image can be used to generate a whole view. By contrast, other style combinations are *unitary,* as is the case with Wholist-Imagers where neither dimension can provide an analytic perspective and Analytic-Verbalisers where there is no imagery or whole view. Taken overall, complementary styles probably impose a higher processing load than do unitary styles. Riding and Wigley speculated that Wholists without any analytic facility will be ale to see all aspects of a situation in balance, while Analytics who do not have a wholist aspect will focus on order and control. By contrast,

[1] The *Cognitive Styles Analysis* is available in various languages: English versions for the Australasian, North American, South African and UK contexts, and also in Arabic, Dutch, French, German, Malay, and Spanish.

complementary style with access to both wholist and analytic facilities will be inclined to switch between the modes requiring additional processing capacity. (For a more extensive consideration of Unitary versus Complementary styles see Riding and Rayner, 1998, pp123-124).

Interactions between the Variables

Possible interactive effects between the variables are shown in Figure 1. As already noted above, the basic and established effect of the variables upon one another is with respect to working memory capacity, cognitive confusion and anxiety-stability. Increased anxiety decreases available working memory, and this in turn reduces information processing efficiency and increases cognitive confusion that then could increase anxiety.

Free working memory is likely to be affected by the processing load imposed both by a cognitive task and the way in which the individual processes it. With respect to cognitive style, unitary style combinations (Wholist-Imagers and Analytic-Verbalisers) are likely to impose a higher processing load than the complementary styles (Wholist-Verbalisers and Analytic-Imagers).

Aims. The aim of this study was to consider how anxiety-stability is related to working memory and style.

METHOD

Sample

The sample comprised 179 (104 males and 75 females) 12-13-year-old secondary comprehensive school pupils in the UK representing all Year 8 pupils in the school who completed the assessments. (In the UK school years are numbered beginning at the start of full-time schooling at age 5 years).

Materials

Anxiety-Stability. In the school, as part of a study of behaviour, teachers were asked to rate the anxiety-stability of each pupil on a six point scale from 0 to 5 on the item, ‘Is confident.

E.g., Is not anxious, high self-esteem, relaxed, does not fear failure, is not shy, afraid of new things, is robust', 0 being unstable and 5 being stable. The rating was done by the Year Tutor and the teachers of English and languages (French or German). The rating was taken as the mean of the three ratings.

Assessment of Working Memory Efficiency. *Information Processing Index* (Riding, 2000a). This computer-presented assessment showed railway trains comprising carriages of different colours entering the left end of a station into which the whole train disappeared from view and then reappeared on the right side with some carriage colours changed. Under the control of the subject the train entered the left side of the station where it was totally obscured from view and then emerged from right side of the station one carriage at a time. The colours of some of the carriages were different from that on entry. The number of colours used was seven. The task was to indicate by pressing one of two marked keys, whether or not each carriage colour had changed. This was done as each carriage emerged from the station.

Subjects were able to view the train for as long as they wished before they caused it to enter the station. While it was in the station and obscured from view they had to remember the carriage colours. When they made the train appear out of the station they had to judge whether there was a carriage colour change and respond while retaining information about the remaining carriages that were still obscured. Except in the case when there was only one carriage, both retention and information processing was required, and both the amount to be retained and the quantity of processing increased with the length of the train. Thus the number of carriages correctly identified was taken as an indication of working memory capacity.

The length of the trains ranged from one carriage to five carriages with four presentations of each train length in ascending order of length. There were thus a total of 60 carriages to be assessed. Presentation of the carriage colours and changes was pseudo-random so that each presentation was slightly different but very nearly half of the carriages were unchanged in colour on each presentation. The score was the percentage of judgements that were correct[2].

[2] In the published version of the *Information Processing Index* in order to raise the ceiling, the train length has been increased to six carriages and the total number of carriages to 85.

The *Information Processing Index* test was individually administered in a computer room with typically 14 pupils per session.

Assessment of Cognitive Style. The computer-presented *Cognitive Styles Analysis* (Riding, 1991) was used to determine a pupil's position on the two fundamental cognitive styles, which was indicated by two ratios; the Wholist-Analytic ratio and the Verbal-Imagery ratio. *The Cognitive Styles Analysis* was individually administered in a computer room with typically 14 pupils per session.

Procedure. In the school, the stability rating, memory and style measures were collected during the last (Summer) term of the school Year 8.

RESULTS AND DISCUSSION

Relationship between Gender, Working Memory and Style

The correlation between the variables of gender, working memory capacity and the two style ratios were all low and non-significant (no greater than r= ± 0.07, P>0.05), suggesting the independence of the dimensions. The means are shown in Table 1.

INSERT TABLE 1 HERE

Divisions of Individual Difference Variables. In order to consider the relationship between the individual difference variables and the anxiety-stability rating, each individual difference dimension was divided into two approximately equal groups or, in the case of Wholist-Analytic style, into three groups. The sample was not large enough to have both style dimensions with three divisions.

Each of the cognitive style dimensions was divided according to the secondary school standardisation sample, (see, Riding 2000c) into two divisions as follows – Wholist-Analytic dimension: Wholists, 0.20-1.02; Analytics 1.03-4.41; and the Verbal-Imagery dimension: Verbalisers 0.65-1.07; Imagers 1.08-3.95. The measure of working memory capacity was divided at the IPI median for the present sample into two groups - low 40.0-85.0; high 85.1-98.3.

With respect to stability and working memory efficiency, where variables are likely to be related there is the problem of deciding which should be taken as dependent. For the analysis of the results, stability will be taken as the dependent variable, and causality will be discussed below.

An analysis of variance was performed with the independent variables: Wholist-Analytic style [2], Verbal-Imagery style [2], gender [2], working memory measure [2], with the anxiety-stability rating as the dependent variable. All significant effects will be reported and these were as follows.

IPI and Cognitive Style. There was a significant effect of IPI, ($F=9.35$; df 1,163; $P=0.003$), with high working memory capacity being associated with higher stability scores. This is in line with the relationship between anxiety level and memory capacity as observed by several researchers, (e.g., Eysenck, 1992; Calvo and Eysenck, 1996; Elliman, Green, Rogers and Finch, 1997; Hopko, Ashcraft and Gute, 1998).

There was a significant effect of Wholist-Analytic style, ($F=5.24$; df 1,163; $P=0.023$), with the Analytics being more stable than the Wholists supporting the assumption that induced anxiety requires an analytic approach to deal with the environmental threat (Baroun, 2005). The interaction between IPI, Wholist-Analytic style and Verbal-Imagery style was significant, ($F=5.76$; df 1,163; $P=0.018$), as shown in Figure 2.

INSERT FIGURE 2 HERE

The cognitive style groups have been ordered form unitary to complementary style combinations.

IPI has the smallest effect on stability with Wholist-Imagers and the largest effect with Wholist-Verbalisers. As already noted, unitary styles are when both dimensions of style can only be used in the same manner, while with complementary styles one can double as a missing style. For instance with Wholists who are Imagers there is no analytical facility, whereas with Wholists who are Verbalisers, the verbalising aspect can be used as an approximation of an analytic facility. This effect may be related to the fact that complementary styles probably utilise greater processing capacity due to their switching

between processing style types for any given task whereas unitary styles are limited to one processing style type for any given task thus requiring less capacity. Consequently complementary styles with high working memory show lower anxiety scores than those with low working memory and vice versa for the unitary style groupings.

DISCUSSION

Variable Interaction

As noted above, there is difficulty in deciding which variables are most fundamental and which dependent on others. For the analysis of the results, stability was taken as the dependent variable. However, causality needs to be considered.

If stress increases anxiety, which reduces the effective working memory capacity, then there is the problem that this reduction causes misunderstanding, confusion and uncertainty when processing information. This may in turn cause further stress and hence increase anxiety. There will thus be the possibility of a cyclic effect.

Working Memory Differences

In Figure 1, taking just working memory and state anxiety, there will be a cyclic effect where the effective working memory capacity - or the capacity required - or the processing load - will be affected by the level of state anxiety (Eysenck, 1992; Calvo and Eysenck, 1996; Elliman, Green, Rogers and Finch, 1997; Hopko, Ashcraft and Gute, 1998).Thus, working memory capacity will influence the degree of cognitive confusion. Low working memory capacity causes confusion and uncertainty because of the problems of decision-making, forgetfulness, and comprehension. This will increase stress and hence level of state anxiety. If cognitive confusion increases state anxiety, which in turn reduces the working memory capacity, then there is the problem that this reduction causes misunderstanding, confusion and uncertainty when processing information. This causes additional stress and hence further increases anxiety. There will thus be a degree of cyclic effect involving state anxiety and working memory efficiency.

Moving outside this cycle, the level of state anxiety will be influenced by trait anxiety and by the level of external stress to which both the school and the home will contribute. The

dependant measure considered in this study reflects the combination of both state and trait anxiety and is a measure of how the teacher perceives the child's state as a reaction to academic work or classroom tasks.

Further, working memory capacity will be influenced by the processing requirements of the style types. Two style types will need more processing - the Wholist-Verbalisers and the Analytic Imagers - than the other two, Wholist-Imagers and Analytic-Verbalisers. A possible reason for this is that Wholists who lack any analytic facility will be able to see all aspects of a situation in balance and will not focus just on some negative aspects. In reality, nothing is totally bad, only some parts and this style evens out the bad with the good. Similarly, those who have only an analytic facility will have everything ordered and under control (Baroun, 2005; Salovey & Rodin, 1985; Sedikides, 1992) and will perceive less stress. Those who seem most susceptible to anxiety are those with the facility to switch between the two modes. The switching requires additional processing which in low memory situations causes additional working memory confusion and hence increases state anxiety - reduced state stability.

Conclusion

This study has shown that working memory and cognitive style interact in their effect on overall anxiety-stability levels for children in the classroom situation. More specifically it indicates that for low working memory children with a complementary cognitive style anxiety in the classroom may be a significant problem in that this combination may give rise to increasing levels of instability due to a cyclical affect of decreasing working memory capacity and increasing levels of anxiety.

The present study was limited in sample size. This is a common problem with individual difference studies, since ideally a very large sample would be desirable. With a larger sample, three levels of each of the style dimensions could be used and this would probably show a more complete pattern.

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TABLE I. SUMMARY OF VARIABLES

VARIABLE	RANGE	MEAN	SD
STABILITY	0.67-5.00	3.46	0.93
IPI	40.0-98.3	82.80	11.68
GENDER	104 M 75 F		
WHOLIST-ANALYTIC RATIO	0.20-4.41	1.12	0.41
VERBAL-IMAGERY RATIO	0.65-3.95	1.12	0.33

FIGURE 1. VARIABLES CONTRIBUTING TO STATE ANXIETY

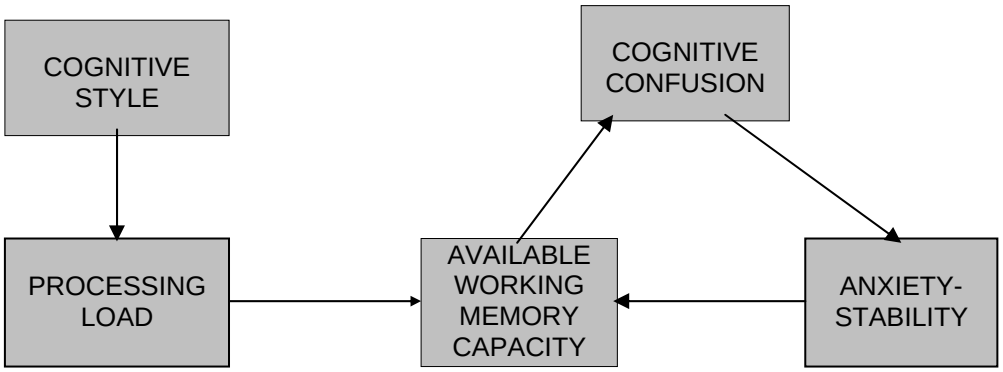

FIGURE 2. ANXIETY-STABILITY,IPI AND COGNITIVE STYLE